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# Sustainability in Concrete Construction: A Future Approach

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A B S T R A C T

With growing population and industrial demand, the waste exploitation grows insignificantly every year around the world and is not recycled in accordance with climatic demand. As a result, recycling waste consumes energy and pollutes the environment. Managing demolished concrete and waste has become a critical problem for all nations around the world in recent years. Demolished concrete, agricultural waste, glass, and plastic are among the waste, posing a disposal problem once they have been used. To deal with such a situation, such waste can be used as a source in concrete production by replacing some of the original content of aggregates with these aggregates.The recycling of these waste materials in concrete not only helps with solid waste management, but it also reduces the use of natural resources. As a result, this review paper will provide insight into the use of waste materials as a source during the concrete manufacturing process.

Keywords: Waste material, recycled aggregates, demolished concrete, aggregate reuse

## 1. Introduction

As population is increasing, waste is also increasing every year with a faster rate. These wastes can be degradable and non– degradable. Non– bio degradable waste remains for long lasting years due to non-decomposition of matters, causing problem of solid disposal. The problem of water handling and management occur all over the world, especially in the countries which are densely populated. In recent scenario, adoption of some waste like plastic, demolished concrete and glass were used as a building material [1]. Hence, disposing a subsequent amount of waste as a disposal mean by substituting a reasonable percentage of naturals aggregate. In the field of construction, concrete is an important construction material around the globe and preferred in all civil engineering works [2]. Aggregates constitute around 3/4th part of concrete element hence it will be advantageous to us to reuse this waste in construction and saving environmental impact due to liberation of heat evolved within it in the form of hazardous gases [3]. Major partof source for emission of carbon dioxide is comes from the cement content and widely used in the production of concrete. To reuse waste materials of construction and agriculture such asdemolished concrete, plastic, glass, coconut shells etc. is a beneficial foot- step to cater these reusable aggregates [4]. In addition, acquiring the recycled aggregate is much easier due to low cost and wide availability than the natural resources. Also, the land fill with these types of wastes have become source of air, water and soil pollution. Now a day's use of such, industrial and agricultural wastes are considered as substitute replacements of some proportion of the conventional aggregates of concrete [5].

## 2. Waste Material

### *2.1. Demolished Concrete waste*

The cost of materials used in construction is growing tremendously. In our country, the price of a cement bag goes on increasing from Rs. 125 to Rs. 380 for a single bag from 1995 to 2020. The exploration of river's sand is banned due to shortages of natural source because of many environmental hazards [6]. Increased interest in environmental protection and development of sustainable environment has led some governments to emphasis on alternate

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resources. Destroyed areas and commercial shut down are the main sources of recycled waste where it can be foundin an abundant quantity. Recycled aggregates are desirable from preserving natural sources perspective and finally preserving natural sources for a late stage which ultimately reducing the trouble of disposal. Recycling as a simple process involves collection of these sources from the sites, transporting to the desired locations, crushing and graining to the desired degree and shapes which fulfil the basic and desired properties. Since the use of these products can be frequently done in road pavements construction hence one should consider the alternatives.The waste material is bringing down to desired shape and size and reflecting approx. same properties as that of ingenious aggregate and these are not affected by original concrete quality. However, aggregates of this concrete show lesser specific gravity and greater porosity in concrete to natural aggregates. These concrete lose workability fast because of porous nature of recycled aggregate. Hence, requiring enough water to get same workability. A good quality recycled aggregate shows good result necessary for crushing and impact test, and Los-Angeles abrasion test [7]. An interchange of aggregate by 45% shows no or little change in strength but higher doses causes reduction in the compressive strength and complete replacement shows a fall of up to 32% deduction in strength directly and also other results may be increase in workability, greater drying shrinkage, creep and modulus of elasticity and greater water absorption when compared with conventional concrete system. From strength point of view, the use of recycledaggregate can be taken in the systems of construction in side roads, bridges, sub-structural element, etc. Table1 shows the experimental work on replacing recycled aggregates in concrete [7–12].

### *2.2. Plastic waste*

Plastic has very low biodegradability hence it remains for up to thousands year in the earth's crust hence its amount increases gradually and finally stored in bulk quantity, causing problem of disposal results in soil and water pollution. Therefore,creating challenge for disintegration of non-recyclable thin plastic waste around the world [13]. Even today around 21% of total plastic waste remains untreated. Many researches were conducted on analyzing the behaviour of non-recyclable waste on the properties of concrete as a substitute of aggregate. The application of this waste into concrete helps in managing environments aspect, as a result enhanced tensile strength of system can be acquired by just aiding of this powdered form of plastic. However, the use of plastic in concrete, makes the concrete weaker in terms of strength when compare with conventional cement concrete. Hence the use of plastic may be preferred where loads are insignificant like drainage boundary, street roads etc.[14]. Literature survey shows that significant numbers of studies also had performed on application of plastic as aggregates in concrete. Table 2 shows experimental study on substitution of fine aggregate by plastic in concreting [14–19].

**Table 1 Reuse of reclaimed aggregates in concrete in place of coarse aggregates**

| Sr. No. | Author & Country | Material Replaced | Percentage Replacement | Examined Properties |
|---|---|---|---|---|
| 1 | Asif Husain, Majid, Motouq Assas | Coarse Aggregates | 0, 25, 50, 75and 100 | Water Absorption, Sieve Analysis, Crushing value, Los Angeles Abrasion, Workability, Compressive Strength |
| 2 | N. Sivakumar, S. MuthuKumar V. Sivakumar, India | Coarse Aggregates | 0, 10, 20, 30, 40and 50 | Acid Resistance, Water Absorption, Workability, Compressive and Tensile strength |
| 3 | Mirjana Malasev Vlastimir Radonjanin, Serbia | Coarse Aggregates | 50 and 100 | Compressive and Flexural Strength, Drying Shrinkage, Bulk Density, Specific Gravity, Water Absorption, Crushability, Abrasion loss |
| 4 | Vinod Sunhere ,Rajesh Joshi, India | Coarse Aggregates | 0, 10, 20, 30, 40and 50 | Slump Cone, Compressive Strength |
| 5 | Prof. Chetna M. Vyas, Prof. Darshana R Bhatt, India | Coarse Aggregates | 0, 20, 40, 60, 80and 100 | Compressive Strength |

**Table 2Fine aggregates replacement with plastic waste in concrete**

| Sr. No. | Author & Country | Material Replaced | Mix Proportion in percentage | Examined Properties |
|---|---|---|---|---|
| 1 | M. M. Rahman, M. A. Mahi, T. U. Chawdhary, Bangladesh | Fine Aggregate | 0, 3, 7, 20,30 and w/c ratio 0.45 | Water Absorption, Compressive Strength, Porosity |
| 2 | Mahaveer Prashad,, Davesh Jayaswal, India | Fine Aggregate | 0, 5, 10, 15 and w/c ratio 0.45 | Moisture Content, Bulk Density, Compressivestrength |
| 3 | M. Mahesh, B. Venkat Narsimha Rao, India | Fine Aggregate | 20 and w/c ratio 0.50 | Compressive Strength, Split tensile strength |
| 4 | Youcef Ghernouti, Bahia Rabehi, Algeria | Fine Aggregate | 10, 20, 30, 40and w/c ratio 0.50 | Compressive Strength, flexural strength, ultra sonic pulse velocity test |
| 5 | M. B. Hossain, P. Bhowmik Bangladesh | Fine Aggregate | 0, 5, 10, 20 and w/c ratio 0.45 | Compressive Strength, Unit weight, Water absorption |

### *2.3. Glass waste*

Huge amount of glass waste is originated every year worldwide. Glass is a non-biodegradable product, and cannot decompose in easier manner. The production of glass involves liquefying the complexes like $SiO_2$, $CaCO_3$ etc. at elevated temperature after that it cools for stiffen which results in crystalline transparent material. The inherent properties of glass are somewhat identical to fine aggregates vis. sand. Hence providing a possibility to use this as a resource material in the mixing of concrete process which will preserve the land from such waste and the aim of decomposition will also solve. This step will ultimately causes reduction in the release of carbon dioxide and some other degrading gases [21]. The application of glass waste as a certain substitution of cement in concrete will result in ecofriendly, economic construction and energy saving step [22]. The glass will undergo two main reactions,in which one is beneficial while other damage the concrete. These reactions are pozzolanic reactions and alkali-silica reaction. Alkali- silica reaction damages the concrete structure [23]. If water to cement ratio is not the subject matter then around 27% increase in strength can be achieved as compared to conventional batch if 20% cement content is replaced by glass waste [24]. However, beyond 20% substitution is under research [25]. Table 3shows the experimental work done on replacement of cement by powdered glass in concrete mix [26–28].

**Table 3Glass waste as an additive in replacement of cement in concrete**

| Sr. No. | Author & Country | Material Replaced | Mix Proportion in percentage | Examined Properties |
|---|---|---|---|---|
| 1 | Veena V. Bhatt, N. Bhavani Shankar Rao, India | Cement | 5, 10, 15, 20 | Compressive Strength, Porosity, Unit weight test |
| 2 | J. M. Khatib, E. M. Negim, Malaysia | Cement | 10, 20, 30, 40 | Compressivestrength, Ultra-sonic pulse velocity test |
| 3 | Gunalaan Vasudevan, Seri Ganis Kanapathy pillay Malaysia | Cement | 10, 15, 20 | Compressive Strength, Bulk density |
| 4 | Youcef Ghernouti, Bahia Rabehi, Algeria | Cement | 15 and 20 | Compressive Strength, flow test, water absorption test |
| 5 | M. B. Hossain, P. Bhowmik Bangladesh | Cement | 10, 20, 30 | Compressive Strength |

## 3. Conclusion

On the above discussion it is concluded that, use of waste asaggregate in the replacement of natural resources fulfils the demand of decompose. The use of recycled concrete causes reduction in strength beyond 40% replacement increasing creep and drying shrinkage of the concrete.Absorption of water of recycled aggregate increases from 1.5% to 4.6% causing more water demand but some artificial plasticizers can be used for this purpose. The reduction in workability of mixed concrete can be eliminated by firstly treating the fibers by saturated state dry conditioning.From study, it is evident that the strength of such concrete made up of recycled aggregate is not lesser of 90% in contrast to conventional concrete.The rate of shrinkage and cracks in fiber reinforced concrete such as glass fiber, plastic fiber and steel fiber concretes are greatly reducing due to compactness and well distribution ofthe reinforced fibers.Hence, these wastes as a source can be used as a partial replacement of aggregate of aggregates which ultimately saving the natural resources and hence this study is providing the guidelines for the user to opt these waste materials in the production of concrete. However, more studies are to be needed to completely eliminate all the undesirable effects and should be adoptable for long run cases. Hence durability of concrete structures reinforced with such fibers should be ensured.

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